DATA QUALITY SUMMARY REPORT FOR TSI SCANNING MOBILITY PARTICLE SIZER DATA COLLECTED BY SONOMA TECHNOLOGY, INC., DURING THE CALIFORNIA REGIONAL PM_{10}/$PM_{2.5}$ AIR QUALITY STUDY

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1. INTRODUCTION AND OBJECTIVES

The purpose of this Data Quality Summary Report is to provide data users with an understanding of the quality of Scanning Mobility Particle Sizer (SMPS) data collected by Sonoma Technology, Inc. (STI) for the California Regional $PM_{10}/PM_{2.5}$ Air Quality Study (CRPAQS). **Table P-1** summarizes the operating sites and times for SMPS measurements during CRPAQS. This report provides summary information on data completeness, lower quantifiable limit (LQL), accuracy, and precision. The SMPS provided size distribution according to particle mobility at different potentials, reported as count data in 51 distinct size bins, with a 5-minute time resolution; only 5-minute data were delivered to the ARB. Data completeness was calculated for all sites based on data delivered to ARB; the start date/time indicates the beginning of valid data, continuous until the stop date/time.

Table P-1. Location and duration of SMPS measurements performed by STI during CRPAQS.

Site	Start Date/Time (PST)	Stop Date/Time (PST)
Angiola Trailer	4/3/00 12:15	2/16/01 19:55

Several other documents are available from which to obtain information about the CRPAQS field study and data processing. Sampling locations are described in Wittig et al. (2003). Quality control screening procedures are summarized by Hafner et al. (2003). Results of systems and performance audits and intercomparisons are provided by Bush et al. (2001). Data quality objectives (DQOs) for the SMPS were not available.

2. DATA COMPLETENESS

Data completeness for SMPS is shown in **Table P-2**. The SMPS size distribution (10 to 400 nm, or 0.01 to 0.4 µm) was reported as particle concentrations in 51 size bins; the size distribution of each bin is provided in Hafner et al. (2003). Data capture quantifies the percentage of total records received versus the number expected during the "period of operation" defined by the start and stop dates in Table P-1; the start date/time is the first instance of valid data, and the period of operation is continuous until the stop date/time. The number of valid data points is divided by the number of captured data points to calculate the data recovery. Validity is defined for this calculation as any data point that has a quality control flag of V0 (valid) or V1 (valid but comprised wholly or partially of below-MDL data). Details of data validation are included in Hafner et al. (2003). For some sites, the data completeness information for several wavelengths (bins) was nearly identical; thus, the results for these calculations were combined. In these cases, the numbers of records and percents are per wavelength (bin).

Table P-2. SMPS data completeness values for the Angiola Trailer 5-minute data.

Bin	Total No. of Records	No. of Expected Records	Percent Capture [a]	No. of Valid Records	Percent Recovery [b]	No. of Suspect Records	No. of Invalid Records	No. of Missing Records
1-46	91,965	91,965	100%	67,959	74%	4177	5264	14,565
47	91,965	91,965	100%	66,049	72%	4177	7174	14,565
48	91,965	91,965	100%	64,854	71%	4175	8371	14,565
49	91,965	91,965	100%	54,964	60%	4163	18273	14,565
50	91,965	91,965	100%	45,252	49%	4163	27985	14,565
51	91,965	91,965	100%	39,191	43%	2826	35383	14,565

[a] % capture = total number of records/expected records*100
[b] % recovery = number of valid records/total numbers of records

All bins had a 100% data capture rate. Data recovery rates ranged from 43% (bin 51) to 74% (bins 1-46).

3. LOWER QUANTIFIABLE LIMIT

The LQL is the lowest concentration in ambient air that can be measured when processing actual samples. Sources of variability that influence the monitored signal at low concentrations include instrument noise and atmospheric variability. As a measure of this variability, two times the standard deviation of selected 5-minute data were used to estimate the LQL. The selected data were taken during periods when concentrations were close to the zero and relatively stable. This is a conservative estimate of the LQL because it includes the concentration variability of the ambient air. Twelve consecutive data values were used to compute the LQL with the 5-minute data.

The LQL is calculated as shown in Equation P-1. **Table P-3** shows the 5-minute LQL for selected size bins, as well as the specific data strings used to calculate the LQL.

$$\mathrm{LQL} \approx 2s = 2\sqrt{\frac{\sum (SMPS - \overline{SMPS})^2}{N-1}} \qquad \textbf{(P-1)}$$

where:

$\overline{SMPS}$ = mean SMPS count
N = number of measurements
σ = standard deviation

Table P-3. Start date/time of period used to calculate LQL (12 points = 1 hour), the LQL, and the corresponding mean count during the selected time period.

Bin	Start Date/Time Used in LQL Calculation (PST)	LQL (count)	Mean (count)
1	11/29/2000 4:45	15.5	2.41
2	1/1/2001 11:05	5.39	0.78
3	12/31/2000 10:15	4.36	0.63
4	11/27/2000 10:35	6.00	0.87
5	1/17/2001 3:15	4.56	0.66
6	12/5/2000 3:55	5.27	0.76
7	12/31/00 9:55	4.66	0.67
8	12/31/00 10:05	5.57	1.35
9	1/1/01 11:25	3.79	0.55
10	2/13/01 3:35	6.17	3.49
11	2/13/01 3:35	4.28	0.99
12	2/14/01 6:10	6.33	3.86
13	2/13/2001 3:50	8.79	2.88
14	2/13/01 3:40	5.46	3.32
15	2/13/01 3:25	5.56	2.82
16	2/14/01 8:20	5.31	2.32
17	2/13/01 3:35	5.58	2.79
18	2/14/01 8:55	5.47	3.15
19	2/13/01 3:15	5.80	2.50
20	2/13/01 3:50	3.19	1.08
21	2/13/01 3:45	4.68	2.02
22	2/13/01 3:50	3.82	1.93
23	2/13/2001 3:25	4.08	2.36
24	2/13/01 3:20	3.20	1.53
25	4/14/2000 20:40	1.38	0.20
26	2/14/01 8:40	4.47	2.28
27	2/13/01 3:50	3.91	1.42
28	2/13/2001 3:40	3.19	1.62
29	2/13/2001 3:45	2.29	0.91
30	2/13/2001 3:50	2.16	0.84
31	2/14/2001 8:20	3.68	1.56
32	2/13/2001 3:45	2.77	1.30

Table P-3. Start date/time of period used to calculate LQL (12 points = 1 hour), the LQL, and the corresponding mean count during the selected time period.

Bin	Start Date/Time Used in LQL Calculation (PST)	LQL (count)	Mean (count)
33	2/13/01 3:45	2.11	0.84
34	2/14/01 6:05	2.50	1.44
35	2/14/01 6:05	1.93	1.24
36	2/13/01 3:55	2.84	1.42
37	2/13/2001 4:00	1.86	0.83
38	2/13/2001 4:10	2.22	0.60
39	2/13/2001 4:10	3.46	0.98
40	2/13/2001 3:30	3.46	1.48
41	2/14/2001 8:55	2.53	0.68
42	2/13/2001 3:35	3.20	1.00
43	2/13/2001 0:10	3.18	1.63
44	2/13/2001 3:55	3.34	1.45
45	2/13/01 3:25	2.62	1.06
46	2/13/01 3:40	2.70	1.09
47	2/13/2001 3:15	3.50	1.45
48	2/14/01 5:50	3.99	0.85
49	1/10/01 20:35	2.77	1.28
50	1/11/01 16:25	1.96	1.62
51	1/11/2001 18:45	3.04	0.44

4. ACCURACY

The calibration of the optical particle counters (OPC) and SMPS consisted of a flow check performed at the inlet located on the sampling trailer's roof, flow checks performed on individual instruments, dynamic zeroes, and polystyrene latex (PSL) checks. Quantitative calibration data were not available for this instrument, nor were flow checks performed regularly enough to calculate a meaningful accuracy of the flow. Therefore, accuracy calculations for this instrument are beyond the scope of this report.

Qualitatively, the PSL checks provide an indication of how well the OPCs and SMPS separated particles of varying sizes. For these checks, moderate concentrations of PSL spheres of known diameter were nebulized and injected in a diluted sample stream. Five spheres of different-sized diameters—4.6 µm, 1.4 µm, 0.89 µm, 0.58 µm, and 0.23 µm—were used. The largest four spheres (0.58-4.6 µm) were measured by the Climet OPC; the smaller four spheres (0.23-1.4 µm) were measured by the PMS Lasair OPC, and the smallest spheres (0.23 µm) were

also measured by the Scanning Mobility Particle Sizer (SMPS). The operator verified that the majority of the spheres fell into the correct size bin of a given instrument by recording the counts in the relevant bins and/or by compiling the computer-generated printouts of the bin counts. All of the documented PSL checks on the Lasair OPC, ground-level Climet OPC, and 100-m Climet OPC passed. The few failed PSL checks on the 50-m Climet OPC were attributed to a misaligned laser diode.

5. PRECISION

Precision can be measured for the SMPS by evaluating the variance of particle counts during a period of low variability when atmospheric influence on variability is assumed to be minimal. Five-minute and 60-minute data were selected during periods of low variability but when concentrations were well above the LQL. The precision was then evaluated by calculating the coefficient of variation (CV) during the period of low variability, as shown in Equation P-2.

$$\text{Precision} \approx CV = \frac{s_{measured}}{\left[\overline{SMPS}\right]_{measured}} \times 100\% \qquad \textbf{(P-2)}$$

where:

$$s_{measured} = \sqrt{\frac{\sum \left([SMPS]_{measured} - \left[\overline{SMPS}\right]_{measured} \right)^2}{N-1}}$$

All the particle count values in Equation P-2 refer to the counts during the selected time period. **Table P-4** shows the precision for each bin.

Table P-4. Precision, the number of data points, start time and mean of the data used to calculate the precision of the SMPS data.

Bin	Start Date/Time (PST)	Mean Count	No. of Data Points Used	Precision
1	5/11/00 10:05	8464	12	5.5%
2	5/11/00 10:10	8870	13	5.4%
3	5/11/00 10:20	9094	15	4.8%
4	5/11/00 10:45	9553	20	5.5%
5	7/11/00 12:10	12932	13	5.8%
6	7/11/00 12:05	14044	12	4.6%
7	7/11/00 12:05	15088	12	3.7%
8	7/11/00 12:25	16089	16	3.1%
9	7/11/00 12:05	18837	12	3.9%
10	10/11/00 12:25	17894	12	3.2%

Table P-4. Precision, the number of data points, start time and mean of the data used to calculate the precision of the SMPS data.

Bin	Start Date/Time (PST)	Mean Count	No. of Data Points Used	Precision
11	10/11/00 12:25	18743	12	2.4%
12	7/11/00 12:05	23919	12	4.2%
13	7/11/00 12:05	24014	12	4.4%
14	9/28/00 14:35	16252	18	2.6%
15	4/27/00 12:05	24202	13	2.8%
16	12/14/00 0:35	3802	13	3.2%
17	12/14/00 0:35	4249	13	3.2%
18	6/26/00 7:00	3230	12	3.0%
19	6/26/00 7:40	3536	20	3.4%
20	6/19/00 6:50	6021	12	2.2%
21	2/14/01 16:15	7446	17	2.2%
22	5/30/00 8:05	5230	12	2.1%
23	8/11/00 13:50	28676	12	1.5%
24	12/14/00 0:30	6919	12	2.0%
25	2/14/01 15:55	5642	13	2.0%
26	12/14/00 0:35	7850	13	2.1%
27	8/16/00 10:05	7442	12	2.0%
28	8/11/00 13:50	17346	12	1.8%
29	8/16/00 10:15	8895	14	1.8%
30	8/16/00 10:25	9606	16	2.0%
31	9/8/00 9:05	4750	12	1.4%
32	9/8/00 9:05	4849	12	1.7%
33	8/11/00 13:55	8970	13	1.0%
34	10/5/00 20:10	4452	12	1.7%
35	9/20/00 10:40	5407	13	1.9%
36	8/30/00 12:05	2619	13	1.9%
37	10/5/00 20:15	3207	13	1.8%
38	10/5/00 9:35	2598	15	1.7%
39	12/13/00 16:30	2048	12	2.0%
40	10/5/00 12:50	1864	12	1.7%
41	11/20/00 8:40	3702	12	1.7%
42	2/1/01 17:25	2584	14	1.9%
43	12/27/00 15:55	5495	12	2.2%
44	12/27/00 16:00	4938	13	2.2%

Table P-4. Precision, the number of data points, start time and mean of the data used to calculate the precision of the SMPS data.

Bin	Start Date/Time (PST)	Mean Count	No. of Data Points Used	Precision
45	1/2/01 9:35	2403	18	3.0%
46	1/19/01 20:25	2103	12	2.7%
47	11/13/00 14:50	617	13	3.0%
48	11/20/00 8:40	840	12	3.8%
49	1/19/01 20:25	1233	12	4.7%
50	1/22/01 18:10	455	14	5.8%
51	12/11/00 13:50	317	15	8.1%

6. REFERENCES

Bush D., Baxter R., and Yoho D. (2002) Final quality assurance audit report - California Regional $PM_{2.5}/PM_{10}$ Air Quality Study (CRPAQS). Prepared for San Joaquin Valleywide Air Pollution Study Agency c/o California Air Resources Board, Sacramento, CA, by Parsons Engineering Science, Inc., Pasadena, CA, June.

Hafner H.R., Hyslop N.P., and Green C.N. (2003) California Regional $PM_{10}/PM_{2.5}$ Air Quality Study management of anchor site data. Prepared for the San Joaquin Valleywide Air Pollution Study Agency c/o California Air Resources Board, Sacramento, CA, by Sonoma Technology, Inc., Petaluma, CA, 999242-2087-FR (scheduled for publication May 2003).

Watson J.G., DuBois D.W., DeMandel R., Kaduwela A., Magliano K., McDade C., Mueller P.K., Ranzieri A., Roth P.M., and Tanrikulu S. (1998) Aerometric monitoring program plan for the California Regional $PM_{2.5}/PM_{10}$ Air Quality Study. Draft report prepared for the California Regional $PM_{10}/PM_{2.5}$ Air Quality Study Technical Committee, California Air Resources Board, Sacramento, CA, by Desert Research Institute, Reno, NV, DRI Document No. 9801.1D5, December.

Wittig A.E., Blumenthal D.L., Roberts P.T., and Hyslop N.P. (2003) California Regional $PM_{10}/PM_{2.5}$ Air Quality Study anchor site measurements and operations. Final report prepared for the San Joaquin Valleywide Air Pollution Study Agency c/o California Air Resources Board, Sacramento, CA, Sonoma Technology, Inc., Petaluma, CA, STI-999231-2332-FR (scheduled for publication May 2003).